Transrenal E-XL stenting to resolve or prevent type Ia endoleak in the case of severe neck angulation during endovascular abdominal aortic aneurysm repair

Emiliano Chisci, MD,[a] Giorgio Ventoruzzo, MD,[b] Neri Alamanni, PPhys,[c] Guido Bellandi, MD,[b] and **Stefano Michelagnoli, MD,[a]** *Florence and Arezzo, Italy*

During endovascular abdominal aortic aneurysm repair, a severely angulated neck can make proximal sealing of endografts challenging, and the occurrence of a type Ia endoleak can complicate the procedure. We describe an original adjunctive procedure involving transrenal placement of a self-expanding nitinol stent (E-XL aortic stent; Jotec GmbH, Hechingen, Germany) to remodel the proximal aortic neck and treat or prevent type Ia endoleaks in the case of severe angulation of the proximal neck. (J Vasc Surg 2013;57:1383-6.)

An unsuitable proximal neck is one of the main factors limiting the wider applicability of endovascular abdominal aortic aneurysm repair (EVAR).[1-6] The efficacy and safety of EVAR remain disputable in the presence of aneurysms with complex proximal neck morphology, and a severely angulated neck, in particular, is considered challenging for EVAR as it hinders achievement of a reliable proximal seal. The most serious complication of EVAR in aneurysms with angulated necks is late aneurysm rupture caused by a type Ia endoleak, with or without concomitant graft migration.

We describe an original adjunctive procedure involving the transrenal placement of a self-expanding nitinol stent (E-XL aortic stent; Jotec GmbH, Hechingen, Germany) to remodel the proximal aortic neck and treat or prevent type Ia endoleaks in the case of severe angulation of the proximal neck.

CASE REPORT

An 81-year-old woman was admitted to the emergency room with abdominal and lumbar pain, which had developed over the previous few hours. The patient's history included cardiopathy, a severe aortic valve stenosis that required repair, chronic atrial fibrillation, hypertension, dyslipidemia, and nicotine abuse. An abdominal pulsating mass was present. An emergency angio-computed tomography (CT) scan showed a 65-mm abdominal aortic aneurysm (AAA). The diagnosis was symptomatic AAA. Considering the patient's comorbidities, the anesthetist indicated EVAR as the only practicable approach. The anatomical characteristics of the AAA were outside the instruction for use for any commercially available devices (angulated, reverse-tapered neck with double angulation, $\alpha = 70°$, $\beta = 90°$; Fig 1, *A*), but the patient's rapidly worsening clinical condition prompted urgent treatment.

After vascular access (bilateral femoral cut-down) was achieved and both renal arteries were correctly located, the main body was delivered (Endurant device ENBF2516C145EE; Medtronic CardioVascular, Santa Rosa, Calif). The contralateral leg was then deployed (Endurant device ENLW1616C95EE; Medtronic CardioVascular). After deployment, postdilatation of all fixation zones and the overlapping zone was performed with a compliant aortic balloon catheter (Reliant; Medtronic CardioVascular) to achieve optimal alignment of the graft material to the vessel wall. Nevertheless, a huge intraoperative type Ia endoleak was found at angiography (Fig 2, *A*). We initially reinflated the balloon in the proximal landing zone, but without success. A proximal extension cuff was not placed because no room was left between the covered part of the graft and the lowermost renal artery. At this point a self-expanding nitinol stent (E-XL 32-130 mm stent; Jotec GmbH) was placed from the distal descending thoracic aorta to the distal part of the main body of the Endurant graft, to remodel the double aortic neck angulation and ensure good apposition of the stent-graft to the vessel wall. This adjunctive maneuver solved the type Ia endoleak (Fig 2, *B* and *C*). The patient recovered uneventfully from the procedure. At the 1-year follow-up, a CT scan showed the perfect patency of all visceral arteries and the two renal arteries,

From the Department of Surgery, Vascular and Endovascular Surgery Unit, "San Giovanni di Dio Hospital," Florence[a]; the Cardiovascular Department, Vascular and Endovascular Surgery Unit, "San Donato Hospital," Arezzo[b]; and the Configuratori.it SRL, Florence.[c]

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Reprint requests: Emiliano Chisci, MD, Department of Surgery, Vascular and Endovascular Surgery Unit, "San Giovanni di Dio" Hospital, via Torregalli, 3, 50124, Florence, Italy (e-mail: e.chisci@gmail.com).

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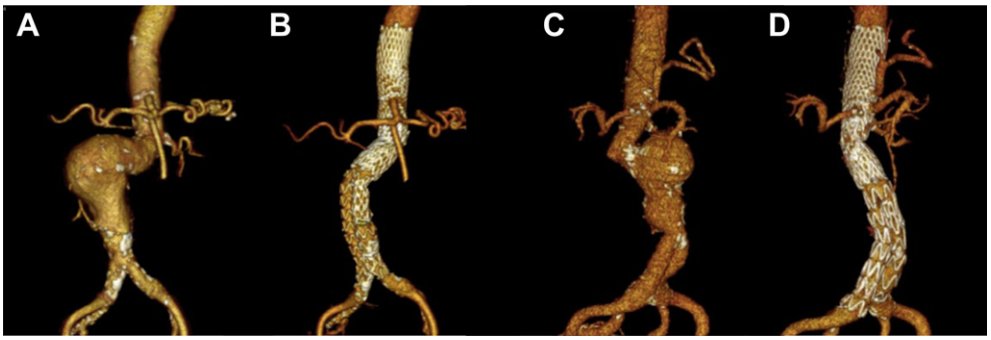

Fig 1. Pre- and postoperative computed tomography (CT) scans showing the challenging angulated proximal aortic neck and the remodeled neck following endovascular repair. In both case 1 **(A** and **B)** and case 2 **(C** and **D)**, the follow-up CT scans show the absence of any endoleak and the patency of all visceral and renal arteries.

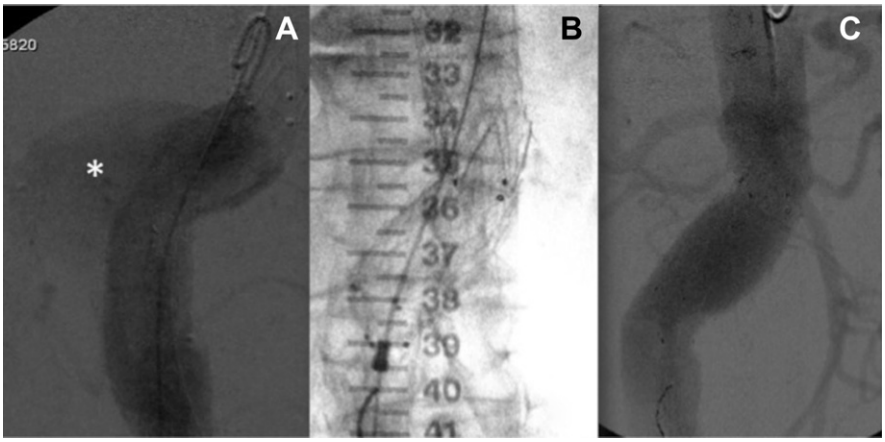

Fig 2. Intraoperative images for case 1. **A,** Type Ia endoleak postballooning; **B,** placement of the E-XL stent (Jotec GmbH); **C,** resolution of the endoleak at the completion angiography.

the absence of a type I endoleak, sac shrinkage of 11 mm, and significant aortic and hemodynamic remodeling (Figs 1, *B*, and 3, *A-D*).

After the first successful case, this technique was used in another similar case (76-year-old high-risk male patient with symptomatic 58-mm hourglass AAA, angulation: $\beta = 87°$) using a different stent-graft (E-Vita device; Jotec GmbH; 73MB2414L15-10 + 75CL1620L05 as a homolateral iliac extension, and contralateral leg 75CL1624L07) with the subsequent deployment of an E-XL 28-100 mm stent. In this case, the E-XL stent was deployed using the technique of primary stenting to remodel the proximal aortic neck and avoid type Ia endoleak, as shown by the 15-month angio-CT scan (Fig 1, *C* and *D*). Moreover the hemodynamic configuration (Fig 3, *E-H*), which had been altered prior to the EVAR procedure because of the severe angulation, was improved.

DISCUSSION

To the best of our knowledge, the technique of transrenal stenting using a nitinol stent (E-XL stent) after EVAR to repair or prevent a type Ia endoleak in a case of severe proximal angulation has never previously been reported. Both EVAR procedures were technically successful despite being performed outside the instruction for use for any commercially available devices, particularly with reference to the severely angulated proximal neck. The E-XL stent was deployed as provisional and primary stenting during EVAR. As an alternative, placement of a giant Palmaz stent (Cordis Endovascular, Great Lakes, NJ) has been described to straighten the anatomy and ensure circumferential apposition of graft material to the aortic wall.[6-9] The rationale is the same: to increase the technical success of the procedure and reduce complications related to the hostile neck configuration, as well as consequent secondary interventions during follow-up and their related costs. For all these reasons the adjunctive cost of E-XL stenting (2500-3000 Euros) is justifiable.

Using the E-XL stent avoided overballooning, as the aortic anatomical configuration was modified positively, ensuring good circumferential apposition of graft material to the aortic wall. Other endovascular techniques to overcome the challenge of an angulated proximal aortic neck during EVAR have been described in the literature.[10,11] In selected cases, the "chimney" technique,[6,12] which creates a proper neck when it is deemed too short for sealing, could be used: the E-XL stenting technique, on the

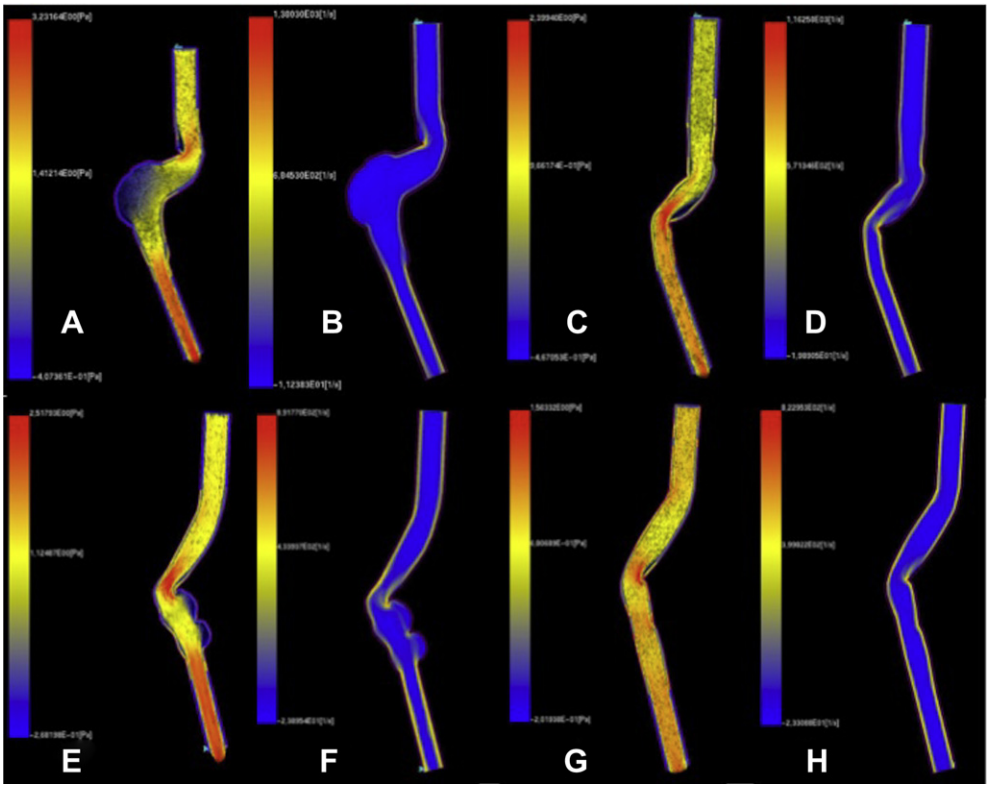

Fig 3. Bidimensional computer models of abdominal aortic aneurysms (AAAs) were built from angio-computed tomography (CT) scan data. Each angio-CT image was coupled with a computational fluid dynamics evaluation performed using an open source software (CSC Elmer, http://www.elmerfem.org/; ElmerSolver, CSC Institute of Technology, Espoo, Finland). Images of cases 1 **(A-D)** and 2 **(E-H)**, showing both anatomic and hemodynamic remodeling after endovascular repair.

contrary, requires a proper infrarenal neck that the fabric can seal. Nonetheless, excessive angulation or particular geometry of the visceral arteries can make the chimney technique very challenging.

In these selected cases, the transrenal E-XL stent was preferred to the giant Palmaz stent because of the need to remodel a long section of the abdominal aorta and the presence of severe angulation. The E-XL stent has enhanced flexibility because of its hybrid nitinol configuration (open cell in the middle, closed at the two edges, with a constant outward radial force of 0.4 N/mm along the length of the device). In contrast, the shorter closed-cell stainless-steel Palmaz stent does not have an outward radial force and should be positioned along the axis of the infrarenal aortic seal zone to correct and improve the orientation of the proximal aspect of the stent-graft, creating more graft-to-aorta contact.[7-9] Self-expanding stent-grafts continue to expand with the degenerating aorta in one-third of patients,[13] and a recent paper[8] has reported a loss of apposition of the Palmaz stent to the stent-graft and a loss of proximal seal zone (>5 mm) in 35% of patients because of this neck enlargement. On the contrary, as the E-XL stent has a proper outward radial force, it should constantly accommodate the neck enlargement, guaranteeing good graft apposition and sealing. A critical issue is cross-renal and visceral stenting, with possible occlusion/dissection of these arteries.[14] Most of these injuries can be solved with endovascular techniques by recatheterizing and stenting the vessels. In our study, we did not observe any renal or visceral impairment at the last follow-up. In both cases reported here, the aorta was remodeled: in the first case, the α and β angles were modified by 25° and 35°, respectively, after EVAR, whereas in the second case, the β angle decreased by around 40°, resulting in better postoperative hemodynamic configuration (Fig 3). This finding could be very important because it has been shown that angulation is the greatest determinant of displacement force magnitude after EVAR,[15] and this force is believed to be partly responsible for migration of the device.[15] We can therefore hypothesize a better follow-up and better late results when angulation of the proximal aortic is successfully reduced.

CONCLUSIONS

The technique of transrenal E-XL stenting described herein seems to be a safe and effective adjuvant approach to resolve or prevent type Ia endoleaks in the case of severe angulation of the proximal neck and in patients considered

at high risk for open surgery. This device is not a competitor to the giant Palmaz stent, but should be reserved for cases in which a tortuous long tract of aorta (>5 cm) needs to be straightened, thus reducing shear stress and leading to effective sealing. More cases and long-term data are required to establish the effective validity of this technique.

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